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Indian Tea Association.

Memorandum on the Use of Artificial Manures on the Tea Estates of Assam & Bengal— Decade 1907-1917.

BY

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With reprint of a Memorandum on the Use of Artificial
Manures on the Tea Estates of Assam & Bengal
prior to 1907

BY

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PREFACE.

This pamphlet contains :—

(1) A "Memorandum on the use of and trade in artificial manures in Bengal, Eastern Bengal and Assam" by Harold H. Mann, D. Sc., sometime Scientific Officer to the Indian Tea Association, published in the Proceedings of the 3rd Annual Meeting of the Board of Agriculture held at Cawnpore on the 18th of February, 1907, and succeeding days.

(2) A "Memorandum on the use of artificial manures on the tea estates of Assam and Bengal, decade 1907-1917" dated 5th September 1917, written for the Scientific Department Sub-Committee, by G. D. Hogg, ph.d., m.sc. fcs., Chief Scientific Officer.

These two Memoranda are now reprinted together in pamphlet form for information.

They cover the entire period during which the use of manures on tea estates has been developing and since the second memorandum was written just ten years after the first, the changes which have taken place during that decade in the policy adopted with regard to manuring can be clearly seen. It is to be hoped that after another decade has passed an officer of the Scientific Department will again write up the subject so that a definite record may be kept of the development in the use of manures by the tea industry.

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MEMORANDUM ON THE USE OF ARTIFICIAL MANURES ON THE TEA ESTATES OF ASSAM AND BENGAL—DECADE 1907—1917.

The purpose of this memorandum is to review the position in regard to the use of fertilizers on the estates in the North East India tea districts, described in Dr. Mann's marginally noted memorandum, written for the meeting of the Board of Agriculture in India, held at Cawnpore in February, 1907.

On the use of
and trade in
artificial
manures in
Bengal,
Eastern
Bengal and
Assam, by
Dr. H. H.
Mann, Scien-
tific Officer,
Indian Tea
Association.

Since that time a remarkable increase has taken place in the annual consumption, by the tea industry, of artificial manures, and by no means all the prophecies which have been made with regard to the directions in which developments would take place, have been borne out in fact.

The substances used as fertilizers on the tea estates of North East India are the following :—

- (1) Cattle manure, and scrapings and refuse from cooly lines :
- (2) Municipal refuse, and factory and other bye-products :
- (3) Oilcakes, Ground oil cakes, and Oil cake meals :
- (4) Ground Bones, Bone Meal and Bone Dust, Steamed Bone Meal, dissolved and degelatinised Bones :
- (5) Fish manures, including whole and milled fish and Fish guano :
- (6) Animal Meals :
- (7) Blood Manures :
- (8) Ground Phosphates :
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- (15) Sulphate and Muriate of Potash, Kainit, and other Potash manures :
- (16) Nitrolim : Calcium Cyanamide and Nitrate of Lime :
- (17) Sulphate and Nitrate of Ammonia :
- (18) Limestone—quick and slaked lime : Gypsum :
- (19) Mixed manures :

Cattle
manure, and
scrappings
and refuse
from coolie
lives.

The available quantity of cattle and lime manure obtainable in the neighbourhood of tea estates is fairly constant, but depends, I fancy, upon the intensity of population, and tends to increase with the influx of coolies to estates and with increase in the number of ex-garden labourers living near estates. Any increase in the use of these substances on tea estates has been due to :

- (a) the neighbourhood of the tea estates becoming more thickly populated, and
- (b) greater effort being taken to collect and preserve these manures.

A large number of tea estates now have special houses, built on scientific principles, for the purpose of storing cattle and coolie lime manures. This is, with probably a few exceptions, a new development since 1907.

Municipal
refuse and
factory and
other
bye products.

These substances are obtainable in small quantities and in particular localities only, such as the neighbourhood of towns, factories, etc. There is but little likelihood of there being a great supply available in the near future nor indeed until new industries develop on a considerable scale.

The only cases of which I know where such substances are produced and are used on estates in the neighbourhood are (a) the use of municipal scrapings in Kurseong and Darjeeling, and (b) that of distillery refuse near Jorehat.*

Shoddy and tannery waste have been used experimentally on tea, but nothing more. Both these materials probably came from Indian factories, though I have been unable to trace the exact sources. Shoddy is a bye-product in the Cawnpore Woollen Mills Company's factory and this company sells about 15,000 maunds of shoddy annually to buyers in the neighbourhood of the factory.

* The distillery at Jorehat has been dismantled since the above was written, so that the distillery refuse is now no longer obtainable.

I have no means of ascertaining the quantity of oil cake <sup>Oilcakes :
Ground
oilcakes, and
Oilcake
meals.</sup> purchased locally for use on tea estates. The price, however, has risen to one which is approximately equal to that of oilcake purchased in Calcutta and despatched to the tea districts, which indicates that the demand has far outstripped the local supply. It is probable that the quantity of oil seed crushed in the tea districts is much greater than formerly, for oil production has been encouraged by the higher price obtainable for oil cake, and probably also by the increased local demand for oil due to increase in population. The greater demand for oilcake generally as a manure for tea is indicated by the large purchases for re-sale for manurial purposes by Calcutta suppliers of ground-nut and other cakes of kinds that are not produced in the tea districts.

About 1890 local mustard cake was obtainable in Assam at 8 to 12 annas per maund. Dr. Mann states that in 1900 large quantities could be bought in the Assam Valley for 14 annas per maund, but that it was difficult to get it at Rs. 1-6-0 a maund in 1905. In 1906 Rs. 1-14-0 per maund was a fair quotation, and since then oil cake has gone to as high a figure as Rs. 2-4-0 per maund, though at present, when bought in considerable quantities, its price delivered on estates is about Rs. 2-0-0 per maund or slightly under. Meggitt states that in Eastern Bengal the price rose within the decade 1902-1912 from Re. 1-0-0 to Rs. 2-0-0 or Rs. 3-0-0 per maund, and states that, price being the limiting factor in its use by cultivators, the increasing demands of tea gardens for local supplies of oilcake are affecting its use by the former. The increase in the price of oilcake affords a clear indication of increased demand.

In addition to smaller village producers there are several big oil mills in existence in the tea districts.

The import of oilcakes from other parts of India to the North East Indian tea districts has increased considerably since the year 1907, and a very much larger area than formerly has been tapped for supplies within recent years. This area cannot exactly be defined geographically, but it certainly includes the greater part of Bengal, Bihar and Orissa, and the east coast of

the Indian peninsula as far south as Madras, where the planting districts of Southern India are in competition with us for oilcake, fish, and probably other manure obtainable in that locality.

Importation of oilcakes for manurial purposes into the tea districts takes place chiefly through Calcutta, and there is now a large purchase, by Calcutta firms which sell manures, of oilcakes of all kinds, including some previously not seen in the North East Indian tea districts. In the majority of cases the oilcakes so imported into Calcutta are bulked and ground and exported to tea estates as oilcake meals, or mixed with other manures.

The Indian Oil Products Company Limited,—a French Company established in 1908 and now managed by Messrs, Graham & Co.,—treats oilcakes by an extraction process and recovers a small percentage of oil and sells the residual oilcake meal as a manure. The oil cake meal sold by this company, which has a higher percentage of nitrogen than that contained in the oil cakes bought for extraction as the result of the removal of the bulk of the residual oil, is composed of cakes of various seeds, and is guaranteed to contain a certain nitrogen content.

Dr. Mann mentions castor, mustard, and rape and their various varieties, til, linseed, and ground-nut cake as having been used on tea estates in and before 1907. These oilcakes are still the kinds chiefly used, with the exception of linseed oilcake, which is chiefly exported in milled form for feeding cattle. Linseed oil cake is still, however, used in small quantities as a manure, one oil mill having supplied 3,000 maunds to tea estates in 1916 ; but this was an exceptionally large quantity. This amount, however, is insignificant in comparison with the amounts now used of ground-nut and other oilcakes of kinds until recently hardly seen in the tea districts. An effort has lately been made to introduce cotton seed cake as a manure for tea, but no great quantity has been used, as the price, in comparison with that of other cakes, is prohibitive.

Mustard and rape cakes are used in large quantities as cattle food in Bengal, Assam and Bihar and Orissa. They are

chiefly produced in villages, and are used quite locally, but it may be supposed that a certain surplus reaches Calcutta.

There are more than a hundred oil mills in Salkea, Sealdah, Howrah, and elsewhere in Calcutta, and I believe that the proprietors of these mills have some understanding in regard to the amount of oil produced monthly by each oil mill, in order to control the total production and consequently the market price. The bulk of this oilcake is purchased by Calcutta firms which deal in oil cakes, such as the Indian Oil Products Company Limited, and other firms which supply oilcakes for manurial purposes.

In addition to this the recent importation into Calcutta in increasing quantities of oilcakes from further afield to supply the requirements of the large manure sellers in Calcutta, has introduced a new factor affecting the movement of oilcakes in and out of Calcutta.

The use of locally obtainable bones has not as far as I am ^{Ground bones} aware increased at all since 1907. This has probably been due to the general impression which prevailed until recently that bones have little value as a manure for tea. Consequently little or no encouragement has been given by planters to villagers to collect bones from their fields as in the case quoted by Dr. Mann. It may be done in certain cases but they are very few.

The bone crushing mills of Bengal crush bones and manufacture bone manures chiefly for export but the tea districts have recently made greater use than formerly of these sources of supply. Although the cost does not compare favourably with that given by Dr. Mann for locally obtainable bones, *i.e.*, about Rs. 42/- per ton crushed ready for application, the supply of the latter is limited, and the quantity available annually would soon become very small and the price would rise if regular collecting on as large a scale as possible were customary.

Bone manures supplied by Calcutta Bone Mills to New Zealand must be steamed for a specified length of time as a precautionary measure against the importation of anthrax into that country, and as the sale of steamed Bone Meal to New Zealand

is on a large scale, the price charged in Calcutta for steamed Bone Meal is very little higher than that for bones crushed to the same degree of fineness and not treated in any other way. Dissolved and degelatinised bones do not appear to be on the Calcutta market and there is no particular demand for them. At the present moment the price of bones in Calcutta compares favourably with that before the war on account of the difficulty of exporting bones from India.

It should be pointed out here that although the increase in the use of bones has been very largely influenced since the war began by the difficulty of obtaining basic slag and the high cost of Superphosphate, there is every likelihood of a considerable increase being maintained from now onwards in the consumption of bones on tea estates. This statement is based on the results of certain experiments made by the Scientific Department, Indian Tea Association, which have indicated the great necessity on many tea soils for phosphatic manures and have demonstrated that bones can be successfully used in promoting the growth of heavy green crops—a matter of great importance on most tea soils.

The annual sales of bones in Calcutta to tea estates have recently been to the extent of thousands of tons annually.

Fish manures
including
whole and
milled fish
and fish
guano.

Dried fish and fish refuse are produced in Bengal and Assam, but not in the near neighbourhood of tea districts.

The chief supplies of fish manures, however, come from the east coast of India and there is a considerable production in Burma.

In 1907 scarcely any use at all was made of fish manures in the tea districts of North East India, but since that time a considerable importation has taken place into Calcutta of fish manures purchased by manuring firms for re-export to North East Indian tea districts. There is now a ready sale of as much of this material as is available, but a difficulty in connection with its use is that there is great uncertainty as to the amount which will be available each year. Two forms of this manure appear to be on the market, one being dried fish, whole or milled, the

other, usually known as Fish Guano, being composed of the residues after extraction of oil by boiling fish.

This class of manure has been on the Calcutta market, under the name of Sterilized Animal Meal, since the year 1906, when Messrs. Moll Schutte & Co. commenced its manufacture from carcasses which they obtained by contract with the Calcutta Corporation and the suburban municipalities.

Animal
Meals:

At the present moment, Sterilized Animal Meals are manufactured in Calcutta, partly from animal residues locally available, such as carcasses, bones, and slaughter-house refuse (which includes horns, hoofs, bones, blood, etc.) and partly from material such as horns and hoofs, bones, blood, etc., imported into Calcutta from elsewhere. Manures which are sold under this name are also made from similar material collected and treated elsewhere in India and the ingredients are imported into Calcutta where they are ground up to the requisite degree of fineness and bulked. The demand for these animal meals has kept pace with the supply, and now the full resources of the municipality are worked, and large quantities of material are also brought into Calcutta for the purpose.

Under the heading Animal Meals may be included a class of manure derived from the sinews, skin, etc. which become detached when bones are crushed. This material, which is not easily crushable and cannot therefore be incorporated readily with manures which are usually sold in the form of meals has been put on to the Calcutta market under various names.

Under the heading Animal Meals may be mentioned horn meal, wool waste, and sundry other animal products, which have been supplied in small quantities to tea estates. There does not appear to be any likelihood that there will be in the near future any extended use of these manures on tea estates, with the possible exception of horn meal which if subjected to proper treatment might prove a valuable nitrogenous manure.

The total amount of actual meat manures is limited in India by the number of large cities which produce sufficient material for their manufacture, and it seems desirable in the interests of

users of manures in India that meat manures should be more exactly defined so as to bring them within a special category inside the larger class of substances described as animal manures, animal meals, etc.

Blood
Manures.

Dr. Mann stated in the note written by him in 1907, which is referred to at the beginning of this memorandum, that blood manures are not used in tea, and it is extremely unlikely that they will be used in the future. This opinion has not been borne out in fact. The suppliers of Sterilized Animal Meal sell a considerable quantity of blood manure some of which comes from Calcutta and some from other parts of India.

Blood though it is chiefly used in the manufacture of Sterilized Animal Meal, has taken up a position in India as a nitrogenous manure irrespective of its use for incorporation with other manures.

Ground
Phosphates.

Ground rock phosphates of various origin have been obtainable from time to time on the Calcutta market and it is deplorable that the same name has been used for several of them, for this is misleading to buyers, because ground phosphates from various sources may be of very different manurial value, as has been proved experimentally already with regard to several so called "flour phosphates" which have been advertised by Calcutta manure suppliers. It is also to be regretted that sellers appear to gamble on the possibility of rock phosphates proving of greater value, relatively to basic slag and superphosphate, than is usually found to be the case in cooler climates and in countries where the matter has been put to fuller test than in India. This tendency is shown in the price which is charged for these materials, with the result that the use of ground rock phosphates has made little or no headway in the tea districts, and is not likely to do so, so long as bones, basic slag, and superphosphate are obtainable, unless the price of these rock phosphates is reduced to one which gives fairer representation of their real manurial value.

The necessity, however, for using phosphatic manures in the tea districts of India is evident, and if a rock phosphate suitable

as such for manurial purposes should pass the test of field trial or could be treated in India so as to give good results in practice, and if this were available in India or elsewhere in sufficiently large quantities to enable it to be quarried cheaply and put on the market at a reasonable figure, there would be an extended use for it. Extensive supplies of this material have I understand been discovered recently. One rock phosphate sold in Calcutta comes from Egypt.

At the present moment the quantities of this class of phosphatic manure used on tea estates is very small. No figures showing the quantities produced in India, are available, but from statements furnished to me by several of the large manure suppliers in Calcutta, it appears evident that the amount of Indian rock phosphates used on tea estates annually has never reached more than about 60 tons and has usually been very much less. Of manufactured phosphates, which usually consist of very finely divided tribasic phosphate of lime, the amounts sold within the last few years although still very small have increased considerably and last year close on 400 tons were sold to tea estates.

This manure has been used for tea for the past ten or more ^{basic slag.} years, though no mention is made of it in Dr. Munn's memorandum. The use of this manure has increased considerably recently, and in view of the excellent results obtained in experiments on the manuring of green crops, made recently by the Scientific Department of the Indian Tea Association, it is likely to do so still further.

At present a low grade basic slag containing only about 10—12 per cent phosphoric acid is alone obtainable, but before the outbreak of war the usual quotations were for basic slag containing 16—20 per cent phosphoric acid.

The only Indian source of this manure is the Tata Iron Works, whence a very low grade slag only is obtainable, which is hardly likely ever to obtain a market as a manure.

All the basic slag, therefore, which is used or is likely to be used on tea estates is imported into India.

Superphosphate.

This manure is manufactured in India and from the economic point of view the manufacture of superphosphate in this country may be considered at present to be dependent on a cheap supply of sulphuric acid, and it is interesting to note that this question is likely to be considered at the end of this year at the next meeting of the Board of Agriculture.

I am not aware to what extent the manufacture of superphosphate in India has increased since 1907. At the beginning of the war the price of superphosphate rose considerably owing to the difficulty of shipping the commodity from Europe, but this rise in price has been checked to some extent by increased importation from Japan, one Japanese firm importing into Calcutta several hundred tons during the season 1915-16.

In 1913-14, phosphates, which include superphosphate but exclude basic slag, were imported to the extent of 850 tons. During 1915-16, the Japanese firm of Messrs. Mitsui Bussan Kaisha, Limited imported 460 tons from Japan into Calcutta.

Guanos -
natural and
artificial.

The only natural guano, I know of which is found in India and is used on tea estates is a small quantity of bats guano from caves in the Garo Hills. The supply is not regularly exploited. Artificial guanos are hardly used. If so, they are simply mixtures of manures imported from abroad.

Any importation of these manures has been on an extremely small scale and has been chiefly for experimental purposes, and Dr. Mann could find no trace of import of or commerce in guanos in 1907, and it seems likely that Dr. Mann's prophecy that this class of manure will not be used in the future is likely to be verified.

The only places mentioned from which these guanos are derived are Peru and Perlis.

Sulphate of
Potash :
Kainit : and
other Potash
manures :

Before the outbreak of war, Sulphate and Muriate of Potash were obtained from Germany through the agency of the Kali Syndicate. The Kali Syndicate was making a great effort to establish the use of potash manures in India, but, as regards tea, since it appears that potash is the manurial ingredient least required at present in the tea districts, the extent of their sales

of potash manures was not very great. Substitutes for these manures have been sought since the outbreak of the war, and small quantities of potash manures of various kinds are now sold in India, though at a very high figure, but it is doubtful whether their production and sale will prove a commercial proposition if and when supplies of potash are again available from Germany.

One source of potash is the acid sulphate which is obtained at present as a bye-product of Indian Sulphuric acid manufacture. This as such is not suitable for use as a manure, but after ignition or neutralization with lime can be so used. Kainit is obtainable in India in small quantities and there are also other soluble potash salts. These deposits are mentioned in the Quinquennial Review of the Mineral Production of India, 1909-13, but I am not aware whether they are being exploited to any extent.

Another potential source of potash is in plant ashes of various kinds such as water hyacinth and tobacco butts, and there is no doubt that with proper organisation for the collecting and treatment of suitable material, an enormous quantity of low grade potash manure could be produced from these sources, but all these sources of supply of potash, with the probable exception of Nitrate of potash, will probably be heard of but little after the war.

The present enquiry on the part of manure suppliers for new sources of potash is mentioned as an indication of an increasing demand for potash salts of all kinds—a demand for potash which could with proper organization be met normally by nitrate of potash.

The Kali Syndicate were however responsible for popularizing the use of Sulphate of ammonia and Superphosphate, manures which figured prominently in their mixtures. For other crops, and in other districts, potash manures may be necessary and it would be rash to assume that there is never likely to be a considerable need for potash manures in the tea districts. Intensive agricultural practice requires all round

manuring and when that stage is reached potash manures will be required. But we have in India the saltpetre industry, and, with proper development, there seems to be no reason why this should not supply the potash required in India for manurial purposes. In regard to imported sulphate and muriate of potash, however, I do not anticipate, when supplies are again obtainable, that the quantity used in the immediate future will increase very rapidly.

The importation of these materials ceased entirely at the outbreak of war.

I have not been able to obtain any Government Statistics of importations of potash salts into India. Dr. Mann (Mysore Economic Journal, January, 1917) states that 1,879 tons of potash manures were imported into India in 1913-14 chiefly into Madras. I do not know whence this figure was obtained.

As far as the experiments have shown, it appears that on most of the tea soils of North East India, of the three manurial ingredients usually required, potash is that which it is least necessary to apply in the form of manure. At present very successful results are being obtained from the application of nitrogenous and phosphatic manures without the addition of potash. There are a few sandy soils, however, which probably require the addition of the last substance, and at the present moment the indications obtained from experiments carried out during the investigation of mosquito blight point to the possibility of potash manures being of use in promoting soil conditions inimical to the full development of attacks of this pest. Before the war sulphate of potash sold by the Kali Syndicate probably represented the best value for money among the potash manures obtainable, but in cases where all round manuring is being carried out there is much to recommend the use of saltpetre.

Before the war broke out America, China and Ceylon used to import large quantities of potash from India, and in Ceylon certainly this was chiefly used for manurial purposes; but since the war began the difficulty of obtaining freights has made it impossible to effect these shipments, and at the same time has

produced a great relative rise in the cost of manures imported into India itself; and this has brought the cost of saltpetre in India into line with that of other soluble nitrogenous manures when the potash it provides is taken into consideration in computing its value.

The prices of saltpetre have gone up within recent years, as is indicated by the following statements. In 1914 Calcutta prices for 20 to 40 per cent. saltpetre ranged between Rs. 5-2-0 and Rs. 6-13-0 per factory maund. In 1915 for saltpetre of the same quality the prices ranged between Rs. 6-2-0 and Rs. 9-4-0 per factory maund, and in 1916 between Rs. 6-2-0 and Rs. 7-14-0 with one sale at Rs. 9-6-0. This year prices have ranged between Rs. 8-2-0 and Rs. 8-6-0 for 25 to 32 per cent. saltpetre. The present price of saltpetre sold as a manure is about Rs. 280/- per ton f. o. b. Calcutta.

It is doubtful whether the cost of nitrate of potash will ever be low enough to permit of its being used in normal times in large quantities as a manure for tea, and this must depend on several factors, one being the increased production of saltpetre, a matter which is now being taken in hand by the Imperial Agricultural Department, whose efforts may lead to great results. Secondly, it ought to be possible, as this substance is produced in Bihar at no very great distance from the tea districts, to arrange for supplies being sent direct to estates and not through Calcutta. This would materially lessen the cost.

Saltpetre is being used in rapidly increasing quantities as a tea manure, and the amount now used is of the order of several hundreds of tons annually.

Practically all the Nitrate of soda used for manuring comes ^{Chili} from Chili. The Chilean Nitrate Propaganda has an office in ^{Saltpetre} Calcutta but actual importations of Chilean Nitrate are not, I believe, effected by them. This manure might prove of great value to the tea industry, but since its introduction into India, its price has been so high as to have entirely prohibited its use in more than small quantities.

In May, 1914, that is, before the outbreak of war, the price of nitrate of soda in Calcutta was Rs. 220/- per ton, at which figure the cost of the unit of nitrogen works out about Rs. 14-8-0. At that date sulphate of ammonia was quoted at Rs. 240/- per ton, the cost of the unit being about Rs. 12-0-0, and oilcake was then obtainable at a cost of something under Rs. 10-0-0 per unit of nitrogen. At present nitrate of soda is quoted at about Rs. 300-0-0 per ton f. o. b. Calcutta and the cost of the unit of nitrogen is therefore just under Rs. 20-0-0, while the cost of this unit in sulphate of ammonia is slightly over Rs. 16-0-0 and oilcake is still obtainable at about Rs. 10-0-0 per unit of nitrogen.

The prices per unit in 1914, quoted above, represent on the average, the relative cost in Calcutta of the nitrogen in these manures for several years previous to the war, and nitrate of soda, though a valuable manure, has no such outstanding merits as would justify one's buying nitrogen at so high a figure, when cheaper nitrogen is obtainable in the forms of nitrogenous manures of recognised value for tea. At present its cost is such that to purchase it in large quantities and for anything but for very special circumstances or for particular soils would be ridiculous.

I believe that there has been some talk of arranging eventually for direct shipment of this manure to India with the object of putting it into the Calcutta market at a figure which would compare favourably with other manures. In this event a considerable use of it in the tea districts is to be anticipated.

Dr. Mann, in his memorandum, mentions that in the year 1905-06 he could only trace import of some 20 cwts. of nitrate of soda into Bengal and could find no trace of any having been sold except by one firm which sold a few cwts. only in three years all of which was used on experimental stations.

Sulphate of
Ammonia.

At the time when Dr. Mann wrote the memorandum above referred to, he stated that very little use was then made of sulphate of ammonia as a manure for tea, but that there were signs of increasing demand. The use of this manure on tea estates is now considerable and the price has all along compared favourably

with that of nitrate of soda and nitrate of lime, and the results of its use have been consistently good. There is now a considerable production of this substance in India, and there is every chance of the price becoming more reasonable practically as there should be no difficulty about buying direct from producers.

In connection with its use on tea estates, it is to be remembered that this manure is likely to be competed for in India sooner than most other manures on account of the rapidity with which it produces noticeable results, which satisfy the most sceptical. Dr. Mann (*Mysore Economic Journal*, January 1917) refers to its established use in Madras, and to the promise of its being extensively used in the Bombay Presidency. The imports to the latter presidency are already considerable. The exports of Indian sulphate of ammonia are at present inconsiderable but may increase in the near future with increase in production.

At present the Bengal Iron and Steel Works, Messrs. The Tata Iron Works, The East Indian Railway Company, the Lodna Colliery Company, and the Oriental Gas Co. produce considerable numbers of tons of this material, part of which is used in India, and part of which is exported. Something like a thousand tons is now used for manurial purposes in India, chiefly for tea.

At the time when the use of artificial manures roused the interest of the tea planting community as a whole, which was approximately coincident with the determination that lime was required in large quantities on many tea soils, nitrolim happened to offer nitrogen at the cheapest price per unit, and since nitrolim possesses the advantage of being an alkaline manure, and many tea estates on which lime had not been used, were obviously suffering from aggravated acidity, it appeared that if this relative price could be maintained, there might be a large field in the tea districts for the use of nitrolim. The price, however has risen considerably since that time, and since the outbreak of war this material has not been obtainable. Dr. Mann quotes the pre-war price in Calcutta at Rs. 160-0-0 per ton and in 1915 its cost was about Rs. 200-0-0 per ton. In 1913-14 it was imported

Nitrolim :
Nitrate of
Lime and
Cyanamide :

to the extent of 120 tons to Madras. In 1915 some 4,300 tons were sold in Calcutta.

A considerable quantity of cyanamide is now manufactured in Japan. A hundred tons were imported into India by one Japanese firm during 1915-16. It must be remembered that nitrolim has also been sold in the form of mixtures and therefore these figures do not represent the total consumption. These figures show that until the time when want of tonnage checked imports, largely increasing quantities of nitrolim were being used on tea estates.

Nitrate of lime has been imported into India but has so far not proved very popular on tea estates, the first consignments were very hygroscopic and difficult to apply. In 1913-14, 603 tons were imported into India almost entirely into Madras. The price in Indian ports before the war was about Rs. 140-0-0 per ton.

Ashes :

Wood and other ashes have been and are used in small quantities as manure on tea estates but the supply is, and will remain very limited.

Limestone,
quick and
slaked lime :
Gypsum :

There has been a great expansion of the use of lime on tea estates for manurial purposes within the last few years. Several reasons have accounted for this, the most important being the realisation of the great acidity of many and the slight acidity of most of the tea soils. In addition to this the increasing use of all kinds of manures has led to the use of some which are acid in character, and lime has been used with the object of counterbalancing the acidity produced by their use. Moreover green cropping has now taken its proper place as one of the most important annual operations on tea estates. Some green manuring plants are used which would hardly grow at all without the previous application of lime to soil, but which, with this treatment, produce excellent crops. Lime is used also as a means of improving the tilth of heavy soils, and lastly, considerable quantities are used in the preparation of spray substances.

Good limestone is fortunately procurable within reasonable distance of the tea districts. Lime is found in abundance quite

near the tea gardens round Sylhet, and in small quantities in the foot hills in the Dooars and elsewhere.

The limestone found in the Dooars is used locally and to a small extent only. Sylhet limestone is used on tea estates locally and is also exported in large quantities to other parts of the tea districts.

The high present price of all varieties of lime is a serious thing and is undoubtedly handicapping the use of lime to the extent to which it should be applied on tea estates. If crushed limestone could be procured at about half its present price or less, and there seems to be no reason why this should not be possible in spite of the difficulties which have been experienced in crushing limestone during the wet time of year, this could be largely used to replace slaked and quick lime, the handling of which is so much more difficult. Freight, of course, is in favour of the two latter forms of lime, but the majority of tea gardens are situated near enough to means of communication by water to obtain crushed limestone by this means of transit in the rains, and this material suffers no deterioration from being stored for any length of time. The objection to quicklime is the difficulty of keeping it dry. If sent in bags a considerable loss is occasioned by the slaking of the lime which bursts the bags. If slaked lime is purchased, it is very difficult for buyers to determine the quality of the lime and the extent to which a supply of water has been added over and above that necessary to slake the quicklime.

Messrs. Gladstone Wyllie & Co. have limestone quarries at Sutna on the East India Railway about 615 miles from Calcutta, the lime for which is used extensively for building purposes, but during the last two years a few hundred tons have been supplied for manuring tea gardens. They have other quarries at Lotapahar on the Bengal Nagpur Railway about 200 miles from Calcutta but lime from these quarries has not been supplied to tea gardens. They have also extensive quarries in the Khasia Hills which are in process of exploitation. Messrs. Kilburn & Co. are agents for the Crushed Limestone Syndicate, which started operations in October, 1914.

Mixed
Fertilizers :

The use of mixed fertilizers has not been encouraged by the Scientific Department of the Indian Tea Association, the opinion being held by Department that it is advisable that proprietors should avoid placing their entire confidence in the statements made by suppliers of mixed manures that the mixtures are admirably suited to requirements.

The acquaintance which the Scientific Department of the Indian Tea Association has with the climate, soil, and other conditions affecting crop on the extensive tea districts of North East India, has made it abundantly clear to them that no firm, unless they have representatives with scientific qualifications spending their entire energies in investigating the problems in situ, can be competent to advise as to what mixtures are best for the soils of each and all of the estates for which they cater.

Good results are no doubt obtained from many manurial mixtures put up by Calcutta firms, but it is a hit and miss method based on general, and not on particular information in regard to estates. Success is no criterion that the manures are being used in the most economical way or that the right mixtures are being employed. I do not mean by the statement to say that mixtures of manures should not be applied. In fact there is much to be said for the applications of several manures mixed together, but the composition of the mixtures must be decided after careful study of the soil, the climate, and the tea plant, as well as of the chemical compositions of the manures.

Several hundreds of tons of mixed manures have been sold annually by Calcutta firms to tea estates during the past few years.

SUMMARY.

To summarize the position as regards manures obtainable in the tea districts themselves it may be said that it is practically unchanged since the year 1907 with the exception that the demand for locally obtainable oilcake has outstripped the supply, and that the recently developed popularity of lime as a manure

for tea, has produced a local market for the lime-stone which is found in certain parts of the tea districts.

The greatly increased demand for fertilizers has been of necessity met by importations from outside the tea districts and from abroad.

Fertilizers obtainable in India from outside the tea districts have been chiefly supplied by Calcutta firms, who have imported manures into Calcutta from other parts of India or from abroad for re-sale to tea estates or to tea garden agency firms. Occasionally, however, particularly in the case of large tea companies, importations of manures from Europe have been effected directly by managers or by the Calcutta agents of the estates.

During the period under review (1907-08 to 1916-17) several changes have taken place in the personnel of the Calcutta manuring market, two firms at least who were prominent at the beginning of this period having ceased operations, while several other firms have taken up the manure trade and are now conducting large business.

Several firms have been throughout suppliers of manures, but they have not sold their products directly to tea gardens, but to other suppliers.

At the present time the tendency on the part of the tea industry, and the suppliers of its needs, is—even apart altogether from the protection afforded at present by the freight conditions produced by the war—to make the fullest possible use of material obtainable in India before importing manures from abroad. Much of this Indian material would otherwise only find much less favourable markets elsewhere, or else would have to be exported from India.

The huge export of bones from, and the growing importations of superphosphate and basic slag into India, afford a paradox which is only explained when it is made clear that no means obtain in India for converting bones into more quick-acting phosphatic manures. The methods of using bones so as to obtain better manurial value from them is now being realised, and there

will be henceforward a greater tendency towards the use in the tea districts of this form of phosphatic manure.

Oilcakes, urgently required as they are by ryots for cattle food, and as manure, were before the war exported in large quantities to be purchased for use abroad, as manure, at prices at which ryots certainly cannot compete. The Indian tea industry comes between these two as a third competitor for oilcake, and, as the figures show, it has expressed an increasing demand for oilcake and has set in motion a search for it over a wider range of country.

Animal meals and Fish manures are made of residues, much of which would be entirely waste material were they not employed as manures, and at present practically the only purchasers of these substances in North East India are the proprietors of tea estates. The same may be said of Blood Manures.

Saltpetre is in demand everywhere and the North East Indian tea estates have now entered the field as a definite competitor for it.

New exploitations of limestone in North East India have been made possible by the demand by the tea industry for lime for manurial purposes.

Finally, other sources of manures are being sought for, and their possibility investigated on behalf of the tea industry alone. The Industry only shows a tendency to obtain manures from elsewhere when these sources prove inadequate. The more intensive lines on which it is developing its agricultural operation, have had, and will undoubtedly have, in the future, much to do with the development of the manure resources of India.

The manures which reach the tea districts from outside India come chiefly from the United Kingdom, from America, before the war from Germany, from Sicily, and since the outbreak of war from Japan.

From the United Kingdom basic slag, superphosphate, sulphate of ammonia, guanos, nitrolim, nitrate of lime, and mixed manures are imported into India.

From America, India imports Chili saltpetre and sulphur only, from Japan superphosphate, sulphur, and nitrate of soda, from Sicily sulphur, and from Germany it received sulphate and muriate of potash.

Oilcakes, and bone, fish, meat, and blood manures have never been imported in more than very small amounts, such as Dr. Mann refers to in speaking of dissolved bones, and, now that a manure manufacturing trade is definitely established in Calcutta, importation from abroad of these classes of materials is likely to decline certainly for some time to come. Ground and treated phosphates too have been imported only experimentally. Saltpetre is obtainable in plenty in India and in other countries it does not, on account of its cost, usually come within the range of substances which can be used in large quantities as manure. Sulphate of ammonia is also obtainable now in considerable quantities in the coal districts of India. Lime is also obtainable in the neighbourhood of the tea districts and hence it is not necessary to import it from abroad.

Dated 5th September 1917.

G. D. HOPE.

MEMORANDUM ON THE USE OF, AND TRADE IN,
ARTIFICIAL MANURES IN BENGAL, EASTERN
BENGAL AND ASSAM,

BY

HAROLD H. MANN, B.Sc.

SCIENTIFIC OFFICER TO THE INDIAN TEA ASSOCIATION.

In the inquiry which was discussed and proposed at the last meeting of the Board of Agriculture relative to the question of the advisability of introducing a system of control over the sale of commercial fertilizers in India, I was asked to undertake to find out the present conditions of the manufacture and trade in Bengal and Eastern Bengal and Assam. At an early stage of the investigation Mr. Coventry was kind enough to tell me that he would collect such data as related to Behar and the indigo districts and this limited the field which my inquiries have to cover.

It was suggested that the class of substances which should be included in the scope of the inquiry should be limited to the following :—

1. Imported fertilizers, such as superphosphates, Chili saltpetre, sulphate of ammonia and the like.
2. All mixed fertilizers.
3. Ground phosphates of every kind.
4. Ground bone and bone char.
5. Guano.
6. Milled or ground oilcake.
7. Blood manure.
8. Milled fish.
9. Refined Indian saltpetre.

To these I have ventured to add 10, sulphur, as although this is not properly a fertilizer, yet its use for agricultural

purposes has enormously increased in recent years, and it stands on much the same basis as to possible adulteration as the others.

Before proceeding to consider such of the above manures as have, or are likely to have, any importance, it may be well to eliminate the remainder. I can find no trace of any import of, or commerce in, two of the above substances, namely, guano and blood manure. It is extremely unlikely that either of these will be imported or used in the future, and in view of this fact nothing more need be said about them.

Of the remainder, some seem to be entirely imported as such, and some to be partly imported and partly manufactured from the raw material here, and some to be entirely country products. To the first of these classes belong Chili saltpetre, ground phosphates, dissolved bones and sulphur, to the second belong superphosphates, sulphate of ammonia and the various mixed fertilizers, while the remainder are entirely made in India itself so far as I can make out. It may be well to consider these various classes of material in this order.

Chili saltpetre or nitrate of soda is imported into Bengal for agricultural purposes in exceedingly small quantities. In the year 1905-06, I can only trace the import of 20 cwts. of this material valued at the port at Rs. 226. I can find no trace of any having been sold, except by one firm, who in the last three years inform me that they have disposed of only 5 cwts., 5 cwts. and 34 cwts., respectively, practically the whole of which has been used for experimental purposes on Government or other experimental stations. Though there is evidence to show that the action of nitrate of soda is not precisely the same as that of saltpetre, yet, in view of the large amount of the latter available here, it is not likely that a large market for nitrate of soda is likely to arise.

Ground phosphates are in a similar position, except for the fact that they furnish the raw material for the manufacture of superphosphate. Considered as manures in themselves, their

present use is purely an experimental one, and so far as I can make out only about ten tons were sold for this purpose during last year. I am informed that the whole of this is of Indian origin, presumably from Trichinopoly, but my informants give no details.

Dissolved bones also prove, rather to my surprise, to be entirely imported as such. The total demand seems to be for 'Indigo factories and Government experimental farms' and, including a small quantity for tea estates, only amounts to a very few tons, the largest dealers only stating a sale of 3 tons during the last year.

Of these three materials, as a result of all the information I have collected, there seems a general impression that there is no room for nitrate of soda, that ground phosphates are only to be considered as a raw material for superphosphate manufacture, and that no extended use of dissolved bones is likely to take place until they can be manufactured locally, which involves cheap sulphuric acid. Only, therefore, the third of these is really within the scope of our investigation, and its extended use is so distant and so problematical that it can hardly be considered a question of practical politics.

Included in this class, however, is the very important material sulphur, whose import has been increasing by enormous strides in the last five years, chiefly for blight destruction (red spider, pink mite, thread blight, etc.) on tea estates. During the last few years the amount imported into Bengal has been as follows :—

			Amount. Cwts.	Value. Rs.
1901-02	...	...	22,314	1,35,351
1902-03	...	...	28,318	1,49,226
1903-04	...	...	34,309	1,73,441
1904-05	...	...	40,974	1,90,977
1905-06	...	...	48,536	2,39,624

Most of this comes from Sicily, but I had a sample sent to me some time ago as from Japan which was available in Calcutta at Rs. 83 per ton, whereas the price of the Sicilian sulphur is

nearer Rs. 100 per ton. I have had a very large number of samples of sulphur through my hands, and they have been, every one, exceedingly pure, and preference between several samples has practically always to be made as a result of determination of *fineness*, the finest being naturally the best for blight destruction. Most of that used is finely ground sulphur, and not in the form of 'flowers,' but the grinding is usually done before importation. This material is rarely purchased through local dealers, usually it is obtained either from the importers or a large Calcutta firm.

Turning to the second class of fertilizers, namely, those partly imported as such and partly manufactured from the raw material in India, I have found very great difficulty in ascertaining the relative amounts imported and manufactured. If we take the whole of the material classified as 'Manure' by the Customs at Calcutta as belonging to this class, the total amount received in 1905-06 amounted to a value of Rs. 4,146 only, of which Rs. 1,718 belong to one single consignment of 'manure for sugar.' This shows the very small extent of the trade. I know three importing houses in Calcutta who have taken up agencies for European manure firms in the last five or six years; of these, one has abandoned the trade altogether, another supplies its few orders locally from another firm, and a third has barely commenced. It may practically be said that Messrs. D. Waldie & Co., of Konnagar, are the only firm in Bengal proper (excluding Behar) who do a serious business in directly imported artificial manures.

The business done in commercial manures of the kinds specified (superphosphates, sulphate of ammonia, mixed fertilizers) which are manufactured or made up from raw materials in India is somewhat greater. Once again with regard to the first and third of these, Messrs. D. Waldie & Co. are, so far as I can tell, the only manufacturers in the districts now under discussion.

As regards superphosphate, the whole amount locally made is only about 40 tons per annum, and shows no tendency to

increase at present. The likelihood of future increase under present conditions is not great, at least in the tea areas. Much would, probably, be used if the price were reasonable, but it costs in Calcutta Rs. 60 to Rs. 65 per ton, or, say, Rs. 80 per ton or thereabouts on a tea estate. This is at least two-and-a-half times as much as in England, and though the benefit derived, even in tea culture, is quite considerable, yet it will certainly (judged by my results at Heeleaka) barely pay the cost of application. The use of larger quantities of superphosphates is therefore intimately connected with a reduction in the price of sulphuric acid. Till this takes place, it will only in rare cases pay for application; if it is once effected, it is quite likely that a slow increase in the demand would arise, but it would be very slow.

The distribution, such as it is, is entirely in the hands of large firms in Calcutta. No local dealer in my districts deals in it. The superphosphate is made and ground by machinery entirely. I have not succeeded in getting to know whether it is prepared chiefly from ground mineral phosphates or from bone ash. Judging by samples which have come into my hands, I should judge it is principally the former. In any case I am informed that such ground phosphates as are used for preparing it are indigenous.

Mixed manures are used in exceedingly small quantities and are of the usual character. "Special tea manure," "special potato manure," and so on are on the market, but the demand is practically nil. I am informed that tea-gardens are the principal customers for these, and the demand from them is certainly not more than, say, ten tons per annum and the trade shows no tendency to increase. They are principally composed of fine ground bones, with superphosphate, and sulphate of ammonia so far as I can tell.

Sulphate of ammonia shows signs of increasing demand in a greater measure than these other materials. It is not, however, for tea, for jute, or for country crops, but almost entirely for sugar and indigo. I may say that *none* is used in the tea industry.

Up to quite recently this has also been a monopoly in Bengal of one firm, and they inform me that their sales have hitherto amounted to under 100 tons per annum.

Now it seems that the manufacture is to be taken up on an extended scale in the coal districts, and no doubt if it can be produced at a reasonable rate, it will be quickly in demand for the abovementioned purposes. Among the purely artificial manures, there is more immediate prospect of the extended use of this material than of any other. It is not likely, however, to extend into native agriculture for a long time, and meanwhile it will be bought in large quantities from the makers.

We have now dealt with all those of the manures about which inquiry was made which are imported either in the form of raw material, or as ready-made fertilizers. There remain those produced in the country, which are really the only ones extensively used. These are—

- (1) Oileake.
- (2) Refined Indian saltpetre.
- (3) Bones, bone char, and bone ash.
- (4) Fish.

Of these, the use of the last-named is exceedingly small. One of my informants states that "Fish manure has come to be used in recent years in small quantities by tobacco growers in parts of the Rungpur District. This manure is not imported as such, but is simply the dry dusty refuse that has been left over from dried fish, which is extensively consumed in Eastern Bengal." I was approached myself some time ago by a Chittagong firm as to what demand there would be from the tea industry if they set up a mill at that port to prepare fish manure, but nothing came of it. Fish may be at present used near the coast or near the rivers, but there is no prospect of any production of fish manure on a large scale.*

* Since writing the above, I have been approached by a Calcutta firm, who offer me five hundred ton per annum of 'animal meal' (chiefly fish, I think) containing 7 to 8 per cent. nitrogen and 12 per cent. phosphoric acid at Rs. 105 per ton.

There are quite a number of bone-crushing mills in Bengal, but nearly all their production is exported. The following are, I believe, all the bone-crushing firms in the Provinces :—

- (a) *Agricultural Phosphate Company, Limited*.—Agents, Messrs. Mackillochan & Co., Calcutta, Works at Ultadanga. These mills crush bones only and *steam* so far as is necessary for export purposes to New Zealand and elsewhere.
- (b) *Bully Khul Bone Mills*.
- (c) *Bengal Bone Mills*.—Works at Balliaghata.
- (d) *Chingrihatta Bone Mill*.—Works at Chingrihatta, Calcutta.
- (e) *Ganges Valley Bone Mill Company*.—A Glasgow firm. Agents, Messrs. Graham & Co. Mills at Uttarpara, Hooghly.
- (f) *Standard Bone Mills*.—Chingrihatta, Calcutta.

In addition to these, there has been a gradually increasing number of tea-gardens who put up their own bone disintegrator, collect bones from the district, crush them, and apply to their own land. The machine used for this purpose is the so-called 'Devil Disintegrator.' One of the planters in Assam, who has had the installation longest, writes me relative to his bone supply as follows : 'I pay Rs. 1-4-0 per maund (80 lb.) delivered at the factory, and it costs me, including labour, Rs. 1-12-9 ready to put on the land. I could now, I think, get the bones for Re. 1 or Rs. 1-2-0. I did not care to reduce the price as I was afraid of frightening the collectors away, as I had a good deal of difficulty in getting them to bring any at first.' Another local planter quite close to the above only pays Re. 1 per maund. The manager of a large tea estate in the Duars, where bones have been crushed for a long time, writes me that the local price of bones is Re. 1 per maund, but most are collected on their own property and in their own bazaars. One planter takes, or did take, all the bones, I believe, from the Darjeeling bazaar.

This is not, however, commercial production. And in considering the possibility of an extended trade in bone meal to the tea districts, it must not be forgotten that these very districts are the sources from which the bone mills themselves draw a large amount of their supply of raw material. Considering that every tea estate has steam or equivalent power on the spot, and bones are to be had locally, it is not at all likely that there will be a large trade in ground bones or bone meal from Calcutta. In fact, the actual use of bought bone meal is getting less rather than increasing.

Apart from the tea industry, bones are not used at all in the area I am considering. Mr. Basu (Assistant Director of Agriculture for the new Province) writes me—"The use of bones is absolutely unknown to the native agriculturist in this Province." This appears also true for Bengal proper. The results of the experiments with bone meal and saltpetre for paddy have, however, been so striking that it is just possible that their use may take a very gradual extension for this crop. It would be absurd, however, to suppose that this can take place with anything but the greatest slowness. For sugar and indigo, bone meal will not take great extension, and, as before stated, the conversion into dissolved bones, or bone ash superphosphate, depends on the presence of cheap sulphuric acid. Bone char is produced in some quantity, but I have only once heard of its proposed use in these districts for manure, and this was for tea.

Summing up all the information available with regard to bones, it may be said that bones are not likely to become a favourite manure for tea, and if they do, it is most probable they will be ground locally on the gardens which use them. For sugar and indigo little is used, and little is likely to be used. For country crops, no bones are used at present, though there is a possibility that, following the experiments at Burdwan, etc., they may take a very gradual extension for paddy. The use of dissolved bones and bone ash superphosphate must await, at least, cheap sulphuric acid.

It may be interesting to give the actual export of bones from Bengal (including Assam) for the last five years, which will indicate the amount available. The largest purchaser is New Zealand, then the United Kingdom, and then Japan.

Year.	Quantity.	Value.
	Tons.	Rs.
1900-01	19,645	7,89,487
1901-02	18,212	9,74,985
1902-03	23,684	12,74,712
1903-04	23,229	15,51,940
1904-05	24,141	13,21,390
1905-06	27,056	15,34,037

During the past year the value of bone meal in Calcutta has been remarkably constant, and it has been quoted with a guarantee of $4\frac{1}{2}$ per cent. ammonia and 52 per cent. tribasic phosphate of lime at Rs. 59-8-0 per ton in the last three months of 1905 to Rs. 61-0-0 per ton from July to September 1906. It has, however, risen to Rs. 65 per ton at the end of the year.

I may say that in the bones and bone meal which have come before me I have found no trace of adulteration or of selling boiled bones as genuine bone meal.

It remains now to discuss the production and use of refined saltpetre and oilcakes, probably the only two artificial manures of present importance and of probable importance in the near future. First, as to refined saltpetre. An enormous number of data on the manufacture and composition of Indian saltpetre have been recently brought together by Mr. D. Hooper (Agricultural Ledger, 1905, No. 3). According to him the principal centres of saltpetre refining are Farukhabad, Cawnpore, Sitapur and Shahjahanpur in the United Provinces, Hissar, Ferozpoor and Montgomery in the Punjab and Saran, Muzaffarpur and Darbhanga in Behar. In Calcutta I may say that in the trade the best class of "refined" saltpetre is almost invariably spoken of as "Farukhabad refined." There are, however, quite a number of small refineries at Narealdanga near Calcutta, but the price

they obtain is never equal to that for the so-called Farukhabad refined saltpetre.

In Calcutta saltpetre is usually sold on a basis of 5 per cent., 10 per cent, or 15 per cent "refraction," that is to say, the impurities are guaranteed to amount to not more than 5, 10 or 15 per cent., as the case may be. In my experience the samples so sold rarely reach the guarantee if moisture be included as an impurity, as it always is by trade. But in our climate this item is very uncertain and I have found the amount vary from '47 to 2'85 per cent. The following are ordinary commercial analyses done by me during the past year of samples bought in the Calcutta bazaar :—

	"Farukhabad refined saltpetre."					Calcutta, refined.
	1	2	3	4	5	6
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture ...	·93	2·43	2·40	2·80	2·85	·47
Common salt ...	1·11	2·42	2·47	3·18	1·63	7·82
Sulphate of potash ...	·19	·88	·95	1·42	·17	·81
Insoluble matter ...	...	...	...	·07	...	·12
Nitrate of potash ...	97·77	94·27	94·18	92·53	95·35	90·75
Total ...	100·00	100·00	100·00	100·00	100·00	100·00
Refraction ...	2·23	5·73	5·82	7·67	1·65	9·25

These were actual representative samples drawn from lots under sale to tea-gardens, all sold on a 15 per cent. refraction guarantee, but it is fair to say that in every case the contract for sale provided for an allowance being made if the refraction was in excess of the guarantee. For instance, the allowance on the Calcutta sample above would be 11 annas per maund, reducing the price in December 1905 from Rs8-10-0 to Rs7-15-0 per maund.

Dr. Leather was good enough to make for me two more complete analyses of samples bought equally in the course of trade and under the same guarantee. The results were as follows :—

	A.	B.
Potassium nitrate	93.12	92.97
Potassium chloride	1.81	2.15
Sodium chloride	1.25	.59
Sodium sulphate ... ..	.89	.70
Moisture	2.08	2.89
Insoluble matter etc. ... ..	.85	.70
	<hr/> 100.00	<hr/> 100.00
Nitrogen	12.92	12.90
Potash	44.52	44.54
Refraction	6.83	7.03

There does not seem to have been much difficulty in regard to adulteration hitherto, and a buyer of any considerable quantity has never had any trouble in getting a guarantee from the traders in the bazaar. And any large adulteration is hardly likely in the future. The only probable addition would be common salt, and this would make the saltpetre quickly so wet, owing to the hygroscopic character of the salt, that it would very quickly be detected in the Indian climate.

By far the largest amount of saltpetre is exported. Mr. Hooper gives the average actual export from India in the ten years from 1893—1903 as follows :—

	Rs.	a.	p.
1893-94—1897-98 = 108,585 cwts. ...	At a price of	11	0 8 per cwt.
1898-99—1902-03 = 371,810 cwts. ...	At a price of	9	15 0 per cwt.

Since 1903 the amount exported from Calcutta to foreign countries has been as follows :—

	Rs.	a.	p.
1903-04 = 386,412 cwts.	At a price of	10	6 0
1904-05 = 343,312 cwts.	At a price of	10	6 0
1905-06 = 332,356 cwts.	At a price of	11	7 0

Hardly any saltpetre is exported from other Indian parts. Of the total quantity shipped in Calcutta in 1905-06, 3,476 cwts. went to Indian ports, the remainder going abroad. The relative quantity from the different sources of supply sent to Calcutta was as follows in the last three years :—

	1903-04.	1904-05.
	cwts.	cwts.
Bihar and other Bengal sources	324,271	259,262
United Provinces	131,011	114,552
Punjab	102,711	81,017
Other parts of India	2,425	1,688

The small use made of material in the area with which we are dealing is shown by the minute amount sent into other parts of Bengal than Calcutta, which was as follows :—

1903-04	...	11,828 cwt.s.
1904-05	...	16,392 cwt.s.

The amount utilised in Assam (where none is made) is exceedingly small also as follows :—

						Mds.	Worth. Rs.
1900-01	...	...	...	...	...	407	1,063
1901-02	...	...	...	...	...	203	1,461
1902-03	...	...	...	...	...	378	2,606
1903-04	...	...	...	...	...	367	2,580
1904-05	...	...	...	...	...	448	2,954

Of course it is by no means certain that these amounts even are entirely used for manurial purposes, but this represents the maximum quantity.

It has been employed more or less experimentally for tea for some years, but never extensively. One large Calcutta firm sent to Assam during the past season no less than 960 cwt.s. to their estates, but this is quite exceptional, and so far tea-planters have fought very shy of these highly soluble manures for their crop. I am not aware of its being extensively used for indigo, but am informed that considerable quantities have been supplied and used on estates under the Court of Wards. In ordinary agriculture, crude saltpetre is occasionally used, but refined hardly ever in the area I am dealing with.

The prospects of its being used on a larger scale in the future depend very largely on the success of the experiments and demonstrations of the agricultural departments concerned. It is certain that it will not push *itself* as a manure, for the high cost and the temporary character of the effect would prevent in any case the rapid extension of its use. The agricultural department of Bengal seems, however, to have shown that combined with bones it forms the most profitable manure known for paddy, and some of the demonstrations of last year were markedly successful. But the adoption of such a method of manuring will be very slow.

The price of saltpetre in the Calcutta market on a 5 per cent. refraction basis varies, as has already been said, with the source of the material. During the year from October 1905 to October 1906 Calcutta refined (5 per cent. refraction) has varied from a weekly average of Rs.7-9-6 per factory maund in January 1906 to a weekly average of Rs. 8-11-0 in November 1905. These amounts are equivalent, respectively (the factory maund being 74½lb), to Rs.227-8-0 and Rs.260-10-0 per ton. At the same time Farukhabad refined saltpetre (5 per cent. refraction) was selling (weekly average) from Rs.8-2-0 per factory maund in March to Rs.10-0-0 per factory maund in July. These prices correspond to Rs.243-0-0 per ton in March and Rs.300-0-0 per ton in July. To give an idea of the value of the lower qualities, I may say that in August 1906, when 5 per cent. refraction (Calcutta refined) was selling at Rs.8-6-0 per factory maund, 10 per cent. refraction obtained Rs.7-10-0 and 15 per cent. refraction Rs.7-2-0 for the same quantity.

As regards tea, it may be said that, while there is abundance of oilcake to be had at anything like the present price, the use of saltpetre is quite unlikely to take any very great extension. The cost is approximately, for 5 per cent refraction, say, Rs.270-0-0 per ton in Assam. Taking the potash as being $\frac{1}{3}$ the value per unit of the nitrogen, this would give a value of nitrogen per ton unit of Rs.10-0-0.

Now oilcake (rape cake) containing $4\frac{1}{2}$ per cent. of nitrogen, 3 per cent. of phosphoric acid, and 83 per cent. of organic matter has been lately costing Re.1-6-0 to Re.1-8-0 per maund of 80lb in Assam, or Rs.37 to Rs.40 per ton approximately. Reckoning phosphoric acid as $\frac{1}{3}$ and organic matter as $\frac{1}{10}$ the value of nitrogen, the value of the last named per ton unit is Rs.6-12-0, or, in other words, the oilcake is very much cheaper. If bazaar castor cake has to be bought from Calcutta, costing, say, Rs.3-8-0 per maund, or Rs.94 per ton, the value per ton unit of nitrogen is Rs.11-8-0, or higher than that in saltpetre. This is dearer than saltpetre, but the price is an unheard of one until the present season. Inasmuch as we want a fairly permanent manure in tea culture, as the

potash is of only doubtful value, and as our soils are usually deficient in organic matter, it will be seen that one cannot recommend saltpetre as against oilcake at present, unless in some special case, and it will probably be some time before the price will justify its extended use.

Oilcake is the best and by far the most important of the materials in North-East India with which I have to deal. At present it is the *only* one of any real importance, and its use is no new thing.

The seeds chiefly used for making it are castor, mustard and rape, in their various varieties, til and linseed, chiefly the two first mentioned. Groundnut cake hardly occurs in Bengal and Eastern Bengal.

By far the largest amount is still made in local village mills, and with their produce the present inquiry has nothing to do. I may say however, that the only case of serious adulteration which has come before me was in such cake, bought locally near Jorhat (Assam), which contained 26 per cent. of sand. This case came before the District Court as an ordinary civil suit, and adequate damages were given.

But there are a certain and increasing number of larger mills, chiefly in Calcutta and neighbourhood. Some of these are large establishments like the British Indian Oil Mills, of Garden Reach, Calcutta, which only work castor seed, or the Gouripore Oil Mills, which only work linseed, I believe. Most of the Calcutta Oil Mills are of a very different type. I quote notes made of visits to two of them.

1. Mill at Halsibagan Road, Shambazar, Calcutta, belonging to Babu Dinanath Mookerjee. This concern is a good one, and the machinery and plant when imported cost nearly half a lakh of rupees. But the oil is not the main business of the mill. It produces a large quantity of flour, which is sold and delivered to large firms. The oil portion of the mill is in a separate building, and six crushers were at work. Only mustard seed is used. Some *Carthamus tinctorius* seeds were noticed about, but they

were said to have come mixed with the mustard seed. The amount turned out was said to vary, but they sometimes produce 5,000 to 6,000 maunds per annum, and could make as much as 10,000 maunds. The cake is chiefly sold to cattle-keepers in small quantities of few maunds, and also to merchants, who resell for cattle-feeding. At least half the produce of the mill is sold for cattle food.

2. The second mill visited was in Goabagan, Calcutta, and is a much smaller one than the last, and is a very primitive one with old fashioned machinery. Castor seed is crushed here, both the large and small-seeded variety being used. The mill probably turns out 1,000 maunds per annum. The oilcake is disposed of through the agency of brokers, said to be principally for export, but the manager has no direct dealings with buyers of oilcake.

These are, probably, two fairly typical Calcutta native mills.

In the districts mills are increasing fast in number. Three years ago one was started in Gauhati for mustard and has been very successful, and new quite large places are being founded at Chandpur, at Parbatipur and at Chaparmukh (Nowgong, Assam). There is also a fair sized mill at Phulehari in Rungpur. In addition quite a number of tea estates are putting up installations for their own use, e.g., the Jorehaut Tea Company, the Scottish Assam Tea Company, the Loongsoong Tea Estate, etc., etc. The Gauhati mill is the largest of these and can turn out 200 maunds of oilcake daily, or, say, 60,000 maunds (between 2,000 and 3,000 tons) per annum. The Chaparmukh mill will make 100 maunds daily. The Assam and Bengal jails produce a certain small quantity.

Any attempt to judge the proportion of the total oilcake supply supplied by mills worked by machinery must be little more than a guess: the amount is constantly increasing, but there is no likelihood of machinery replacing bullock power in the near future. On the whole the cake made by bullock power is remarkably well pressed. Certainly as yet the quantity of oilcake made by machinery is not more than one-fourth of the total, probably much less.

Hitherto there has been an enormous foreign trade in oil-cakes. Linseed cake stands apart, being exported chiefly in milled form for feeding. During 1905-06 (as extracted from the Daily Customs entries) there were exported from Calcutta to foreign countries 22,549 cwts. of a nominal value of Rs. 23,595, though the real value was undoubtedly much higher than this. To Indian ports 524 cwts. were sent of a value of Rs. 3,348. This hardly interests the present question however, for linseed cake, milled or otherwise, is not used for manuring as such at all.

Of other oilcakes, the total export was 358,538 cwts., of which 21,442 cwts. only were re-imported at other Indian ports. Of the total quantity for foreign ports, 18,820 cwts. were declared as for manure.

I have not been able to obtain statistics of the production or places to which the cakes are sent from most of the mills, but can give it for some of them. The British Indian Oil Mills have been kind enough to supply figures for 1904 and 1905 of their 'castor meal' as follows :—

			Exported.	Tea gardens.	Country and local consumption.	Total
			Mds.	Mds.	Mds.	Mds.
1904	...	...	21,530	21,071	2,470	45,071
1905	...	...	7,485	45,316	11,298	64,099

They informed me also that their whole supply in 1906 to the end of August (5,000 maunds a month) were ordered from Japan. Of the oilcake exported as for manure the United Kingdom, China and Japan were the only large importers.

The production of Assam oil mills is entirely absorbed locally, and the same may be said of the other new mills run by machinery.

The details I have been able to ascertain regarding the crops for which oilcake is used are as follows :—

Tea.—The use of oilcake for tea in any large quantity is quite a recent development, but is increasing by enormous strides. One firm of agents last year sent up to their estates

4,050 maunds of cake and meal in 1905-06, and this is by no means the largest amount. It may, in fact, be said that almost every up-to-date concern in the Assam Valley either is regularly using oilcake now, or is experimenting with it. It has penetrated not to quite the same extent into the Surma Valley, and still less into the Duars and Darjeeling, but is becoming more used in each of these districts. As a rule, hitherto, it has been applied to tea at the rate of 10 to 15 maunds per acre, but there is a tendency now to apply less on each occasion and repeat the dose more often.

Sugarcane—(information given by Messrs. N. G. and D. N. Mukerji) is regularly manured with oilcake, bought for the purpose, castor cake being usually much preferred. Twenty maunds per acre is the average amount applied, but even thirty maunds are bought and used for the purpose. In the Assam Valley I am told that practically no oilcake is used. Mr. Basu writes 'the Assamese raiyats may be said to be still ignorant of the use of oilcake as a manure.' Hence sugarcane seems chiefly to be looked upon as a homestead or virgin land crop and is usually poor.

Potatoes are manured commonly in Bengal and Eastern Bengal, but not in the Assam Valley, with oilcake at about the rate of 25 to 30 maunds per acre. I do not know whether oilcake is used for potatoes in the Khasi Hills.

Rice.—Oilcake is occasionally used for autumn rice in Bengal, at the rate of about 5 maunds per acre.

Tobacco.—Rape cake is very largely used by tobacco growers in Rungpur, the rate of application being 2 to 3 maunds per *bigha* ($\frac{1}{3}$ acre) (Basu).

Pan (betel leaf) is manured with small quantities of oilcake in Eastern Bengal, and, I believe, all over Lower Bengal.

Ginger is also manured to some extent in Rungpur with oilcake (chiefly rape or mustard), and it is one of the staples of that district.

The oilcakes principally used, as I have said, are mustard (or rape) and castor, and, except for one sample of 'moula' or 'radish' cake, no others have passed through my hands.

Mustard cake.—The following are samples which I have examined, all locally crushed :—

	MUSTARD CAKE.				
	One year old, North Sylhet	New, North Sylhet	Dibrogharh.	Bishmanth.	Nowgong.
Moisture ...	8.87	8.14	8.44	9.04	19.33
Organic matter ...	83.84	85.04	82.92	80.90	72.30
Lime, phosphoric acid and alkalies, etc. ...	6.52	5.70	6.80	6.67	6.98
Sand ...	.77	1.12	1.84	3.39	1.20
TOTAL ...	100.00	100.00	100.00	100.00	100.00
Nitrogen ...	5.48	5.64	5.17	4.61	4.78

As will be seen, these are all good samples and, except for the Nowgong sample being wet, there is no sign whatever of adulteration. The price is rapidly going up. In 1900 large quantities could be bought in the Assam Valley for 14 annas a maund, now it is difficult to get it at Rs.1-6-0. The demand is so great at present that I doubt whether even mills like those at Gauhati would bother to sell on a guarantee, and my last year's advice to planters was to be satisfied if they get it at Rs.1-6-0 to Rs.1-7-0 per maund (80 lb), reckoning it at $4\frac{1}{2}$ per cent. nitrogen, delivered on the station or ghat. It is probable that during the present year the price will be higher than this. The local material is all bought from the traders in the bazaar, who finance the cultivators who grow the crop. Gauhati and Chaparmukh mills dispose of their produce direct to planters, none going into ordinary agriculture. I have no means of knowing how the produce of the Phulchari and Parbatipur mills reaches the cultivators, but it is almost certain that it is through bazaar traders.

Mustard cake in the Calcutta bazaar has risen in price much during the past year, but not to so great an extent as castor cake.

and it is at present distinctly of better value than the latter. The Calcutta prices for the last year have been as follows :—

	Rs. a. p.	to	Rs. a. p.	
October to December 1905	1 1 0	to	1 10 0	per Bengal maund.
January to March 1906	1 5 0	..	1 11 0	.. ..
April to June 1906	1 7 6	..	2 8 0	.. ..
July to September 1906	1 7 0	..	1 11 0	.. ..

Castor cake.—There are two distinct qualities of castor cake on the market, both of which seem to be pure, but of entirely different value. One of these contains barely 4 to $4\frac{1}{2}$ per cent. of nitrogen, and the other $5\frac{3}{4}$ to $6\frac{1}{2}$ per cent. Curiously enough it is the bazaar castor cake which is high, and that produced by the British Indian Oil Mills which is poor. The latter firms are usually quite ready to guarantee $4\frac{1}{4}$ to $4\frac{1}{2}$ per cent. nitrogen, but not more. No guarantee is of course, obtainable in the bazar. The prices have in the last three years almost exactly been proportionable to the nitrogen content. Thus, when the bazaar cake was Rs.1-14-0 to Rs.2 per Bengal maund (82 $\frac{7}{16}$), the oil mills were selling their cake at Rs.1-5-0 to Rs.1-6-0. The former means 5·3 annas per maund unit of nitrogen, and the latter 5 annas, counting all the value of the cake as nitrogen.

During the last few years, and the present year especially, the price of castor cake has been going up, and during 1905-06 the rise has been almost continual. The prices on the Calcutta market of the bazaar cake in the last year have been as follows :—

	Rs. a. p.	to	Rs. a. p.	
October 1905	2 0 0	to	2 4 0	per Bengal maund.
November ..	2 0 0	..	3 0 0	.. ..
December ..	2 0 0	..	2 13 0	.. ..
January 1906	1 11 0	..	2 2 0	.. ..
February ..	2 0 0	..	2 4 0	.. ..
March ..	1 14 0	..	2 2 0	.. ..
April ..	2 0 0	..	2 6 0	.. ..
May ..	1 14 0	..	2 6 0	.. ..
June ..	2 2 6	..	2 9 0	.. ..
July ..	2 5 0	..	2 10 0	.. ..
August ..	2 5 0	..	2 8 6	.. ..
September ..	2 8 0	..	2 14 0	.. ..

There has, in fact, on the whole been a distinct rise of 8 annas per maund or, say, Rs.13-8-0 per ton during the year.

In May last, when bazaar cake was selling at Rs.1-14-0 to Rs.2-2-0 per maund, the British Indian Oil Mills sent their material to Japan at Rs.1-7-0 per maund f. o. b. Calcutta.

The composition of bazaar castor cake may be seen from the following typical analysis :—

Moisture	...	...	...	...	7.67
Organic matter	...	...	...	...	82.78
Lime	...	...	...	...	.83
Phosphoric acid	...	...	...	...	3.07
Alkalies, etc.	...	...	...	...	3.31
Sand	...	...	...	...	2.34
Total.					100.00
Nitrogen	...	...	...	...	6.46

Other commercial samples gave nitrogen 6.45, 6.52, and 6.07 per cent, respectively.

The castor cake produced and sold by the British Indian Oil Mills give figures as follows :—

Moisture	...	...	...	...	7.53
Organic matter	...	...	...	...	86.51
Lime	...	...	...	...	.20
Phosphoric acid	...	...	...	...	1.41
Alkalies, etc.	...	...	...	...	2.95
Sand	...	...	...	...	1.40
Total.					100.00
Nitrogen	...	...	...	...	4.12

Other commercial samples gave nitrogen 4.38 and 4.36, respectively.

The cake supplied by the British Indian Oil Mills Company is always sold as fine ground meal : the bazaar cake usually in the form of small pressed cakes. It has been objected in tea culture to the meal, that in consequence of its fine state of division its effects are very temporary, but as yet this is by no means certain.

Other cakes than those already mentioned are hardly used in Bengal at all, or if used do not enter in any way into trade.

It is evident from the summary that has been given that the use of commercial fertilisers in Bengal, Eastern Bengal and

Assam is, except as regards oilcakes, in its infancy. As regards such materials as superphosphate, dissolved bones and the like, I feel almost certain that the prices will have to be materially reduced before there is even the remotest possibility of their use taking on a great extension even in planting and still more in ordinary country agriculture. In the case of bones and bone meal, caste difficulties will prevent the extension of them being anything but very slow. With saltpetre there is more likelihood of larger quantities being used in the near future, but here again demonstrations will have to be multiplied largely before this result is likely to be brought about. Cakes are already used in much of the area, and their use is spreading fast without any Government interference.